Infrastructure Requirement for Internet Video Conference using Broadband Networks

Kazunori Sugiura

Communication Research Laboratory(CRL)

Keio University

uhyo@sfc.wide.ad.jp

This presentation consists of 46 Pages

Before I Start with my presentation:-)

- My PPT Files are available at(during the session):

  ftp site: 192.168.0.40
  username: dv
  password: ieee1394

- Available in above ftp servers during session:
  - Full Source code patch for IEEE1394 Interface
  - sender and receiver application(Binaries Only)
    - IPv6, RTP, Multicast, packet discard, packet monitoring
  - sample sources for DV driver application.

Next: Outline

Outline

- Why am I talking about the Video Communication Tools using Internet?
  - Motivation and **NEEDS**.
- Development of Internet Video Communication tool using DV(Digital Video) and IEEE1394.
  - Broadband Network Availability(LAN and WAN).
  - Digital Output Video Interface(a.k.a IEEE1394)
- Some experiment using DV Over IP.
- Broadband Network Killer Applications.
  - May be a good application for bandwidth brokers :-)

Next: Motivations

Motivations

- To establish a Real-time Video Conferencing system with…
  - High Quality Video and Audio
    - NTSC Quality Video
    - >CD Quality Audio
  - Broadband(High Speed) Network Availability
    - Target:
      - LAN Based Conference
        - 100Base-T Ethernet or more….
      - Multicast Communications
      - Availability via WAN.
  - Good killer application for broadband network as …
    - testing queuing algorithm
    - Testing operating system overhead
    - Benchmarks and Interoperability test for switches, routers,etc...

Next: IMHO:Needs

Needs

- I am now working(?) at CRL
  - Communication Research Laboratory
    - Communication System Division, High Speed Network Lab.
- Also….
  - Keio University SFC Student.
    - I am (still) fighting for my Doctor's Degree
- And some extras… (May be a waste of precious time?!:-)
  - WIDE Project Primary (and active :-)) NOC maintenance staff.
  - J-GBN… etc.

ALL IN DIFFERENT LOCATIONS!!!

I will need a good Remote Video Conference System(s)!!

Next: Remote Accessibility

Location Accessibility

Distance in Kilometers

Tokyo Univ.

CRL

NTT, KDD NSPIXP…

Keio University SFC

Keio Mita Campus

Where I Live

Where hxt Lives

Next: Cost for transportation

Cost for transportation

- From CRL to IXP Housing in KDD ¥1300 90min.
- From CRL to Keio SFC ¥1200 90min.

- If I go from CRL to IXP and then back to SFC...

  600+700+700+1250=3250 Yen…
  I will need to waste more than **3 Hours** for transportation

I cannot afford that much money and time all the time!!!...

Next: Plus more

Plus more…

- I Have a collection of…
  - DVD movies(Nearly 300 titles and growing :-)
    - 50% of which are not even opened.
  - Laser discs and Collection Box.(Nearly 400 titles and growing :-)
    - 80% of which are not even opened.
- Estimation of time to see all the unopened titles:
  - {(300 x 50%) x 120} + {(400 x 80%) x 120 x 5} minutes

= about **146 Full Days**….

I would like to see my Video anywhere, at anytime!!

Next: Post phone

What we can use for Location transparency?

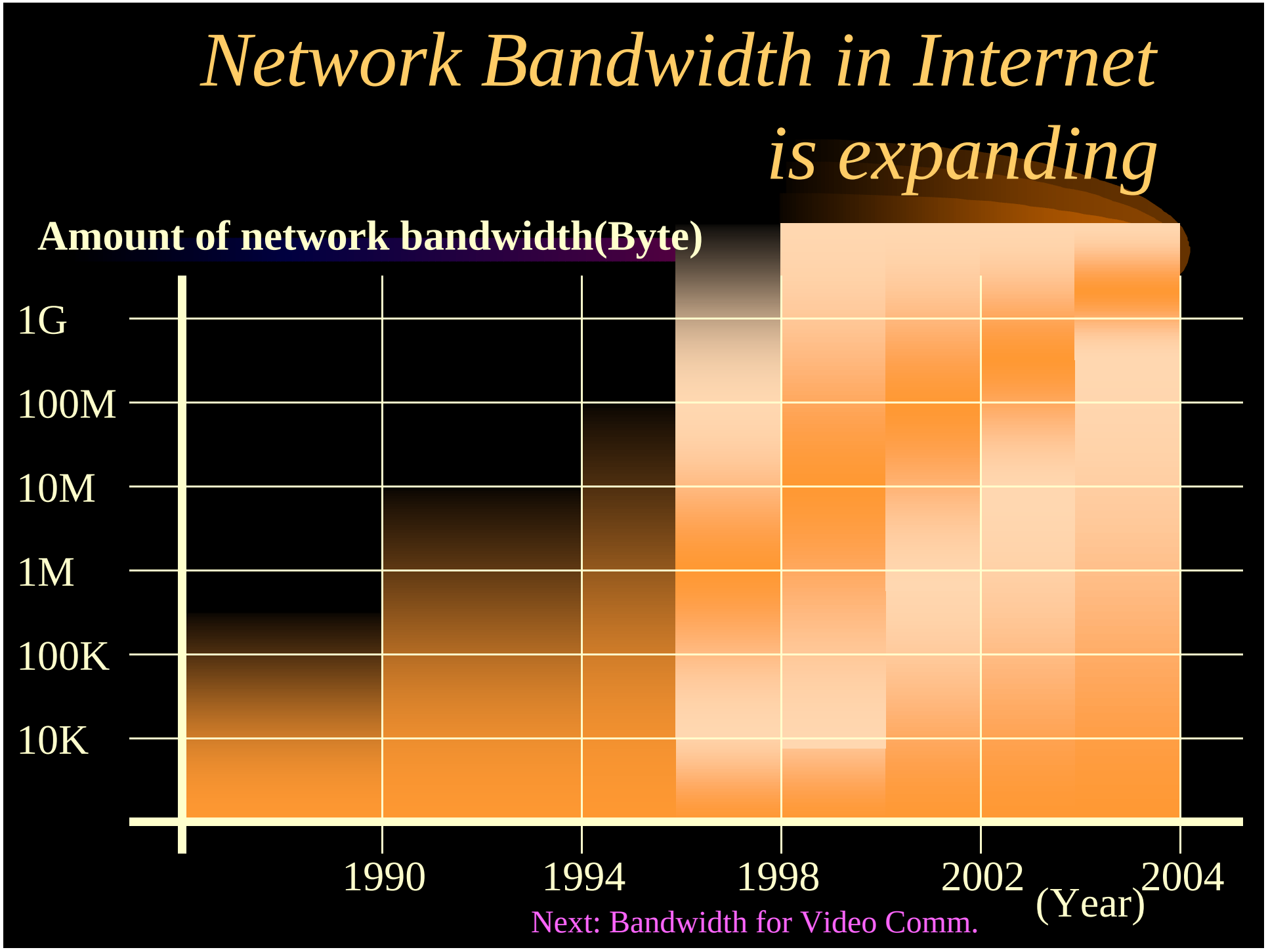
- What can we use for remote conference?
  - Telephone Conference system:
    - Lack of Video Availability
    - How about Interaction?

  - Consumer Video Conference System:
    - Expensive, Lack of performance(ISDN Based…) mobility…
  - Network Video Conferencing system:
    - Lack of Realtime interactions:
      - RealVideo
    - Performance, obsolete applications:
      - Vic, Vat
    - Lack of Multicast implementations:
      - Net Meeting

Network Conference System is a good answer.

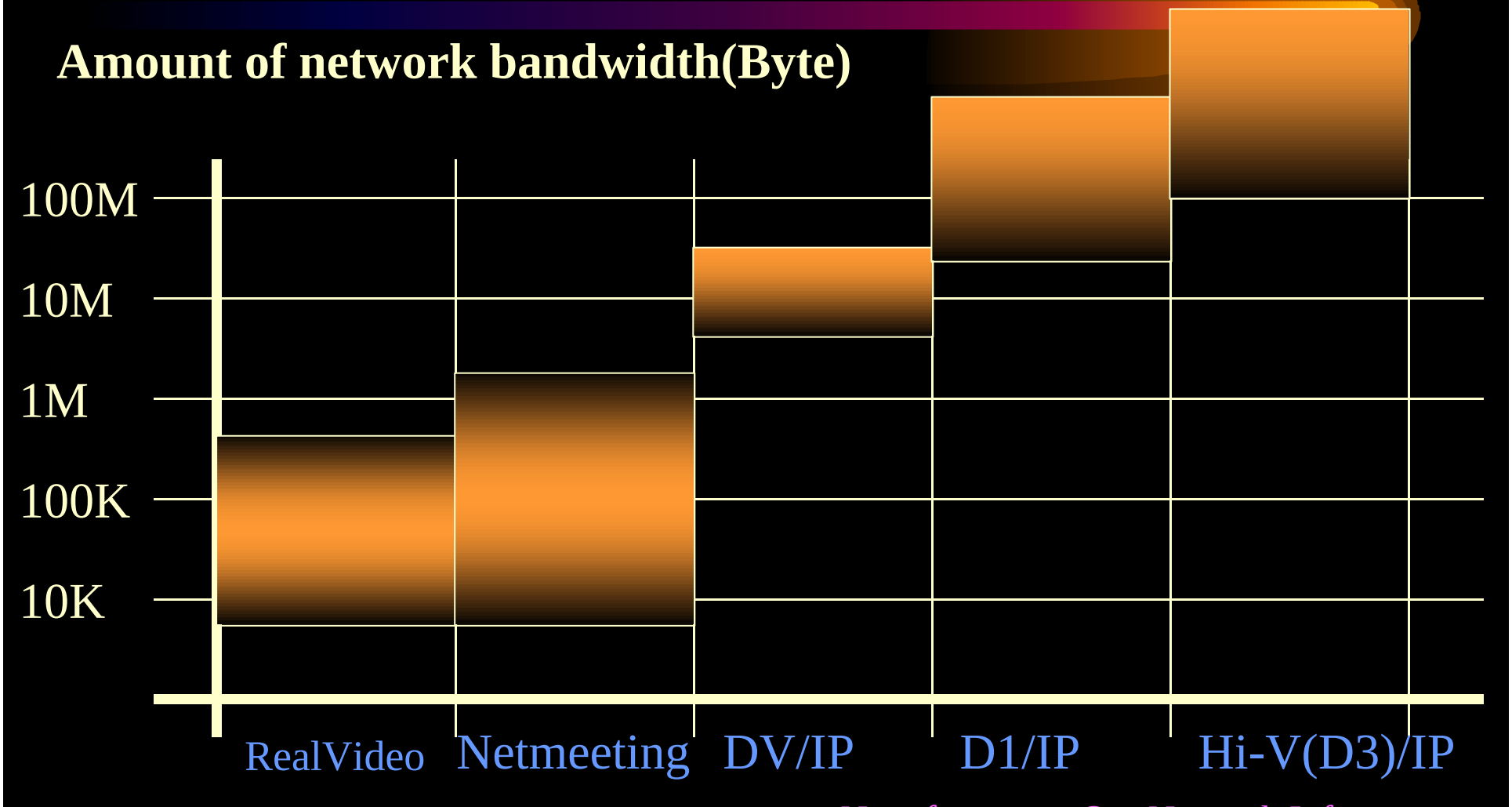
Next: Network Bandwidth

Network Bandwidth in Internet is expanding



Next: Bandwidth for Video Comm.

Video communication System: Network Bandwidth



Next:fortunate: Our Network Infrastructure

Our Network Infrastructure

Next: Current Video Comm tools.

Current Internet Video Broadcasting System

- Limitation in Network Bandwidth
  - Video/Sound encoding cost is enormous.
    - Based on Software Video format encoding.
    - Major Video Capture Interface:
      - PCI Bt848A based encoder board
      - Bi-directional support for Sound
- Consumer application: some are NOT FREE...
- Quality: Massive compression of Video/Audio
- Real time Teleconferencing System
  - High cost equipment is required.
    - Realtime MPEG2 Encoder.

Next: Characteristic of Internet

Characteristics of Internet

- best effort basis network
- Network Characteristics…
  - Weakness in Stream media(Stream packet)
    - Jitter
    - Network Packet losses
    - Congestion Control

Next: Requirements

Summary:Requirements

- High Quality Picture
  - NTSC Quality Video
- High Quality Sound
  - > CD Quality Audio
- Transfer without delay
- Mid range bandwidth(10Mbps and higher)
- low cost solution
  - minimum equipment, maximum performance

Using DV would be a good solution.

Next: Characteristics of DV

Characteristics of DV

- DV Format:
  - 720 x 480 Pixel
- requires bandwidth over 30Mbps
- when using NTSC Output video(525i)
  - 525 lines
  - 29.97 frames per second
- 525p(Progressive will be available)

Next: DV Frame rate and Bandwidth

DV Frame rate and Bandwidth

Mode	Frame rate	Required Bandwidth (over IEEE1394)
525/60	29.97 Hz	29.5 Mbps
625/50	25 Hz	29.5 Mbps
1125/60	30 Hz	59.0 Mbps
1250/50	25 Hz	59.0 Mbps

Next: System Design

Our system Design

- Ease of Availability
  - Consumer DV products
  - Simple IEEE1394 to IP encapsulation
- Network conservation technique
  - Frame discarding method
- packet loss, delay and jitter adaptation
  - Simple buffering/discarding technique

Next: System Requirements

System Requirements

- Standard Pentium,Pentium II based PC
  - requires >200MHz Pentium
  - Intel SE440BX-2 Motherboard
  - NO ASUS P2B-F!!!
  - FreeBSD 3.2

- PCI based IEEE1394 interface card
  - Adaptec PCI IEEE1394 Card
  - Texas Instruments Chipset(PhotoDV,MotoDV)

- 100BaseT PCI Ethernet NIC
- Consumer DV Camcorder with DV Output
- Cables

Next: Software Design

Software Design

- Kernel patch for IEEE1394 device driver
  - character device Lynx,ilink
- DV sender application(dvsend)
- DV receiver application(dvrecv)

Usage : ./dvsend [options] [host/port/ttl]
<options>

-v	: show version number
-h host	: sendto host "hostname"
-f rate	: send full frame by 1/rate
-r rate	: drop packets in random pattern
-I interface	: use interface "interface"
-b size	: set SO_SNDBUF to "size"
-n	: do not always send audio data
-m	: do not send packet with same data
-M interface	: use "interface" for sending multicast packets
-t ttl	: TTL for multicast
-c ch	: recv from 1394 channel "ch"
-p number	: send with RTP payload type "number"
-P port	: use UDP port "port"

Usage : ./dvrecv options
<options>

-v	: show version number
-m mod	: mod (magic number)
-f frac	: frac (magic number)
-I ifname	: the interface to use
-b frames	: number of frame buffer
-r size	: value for SO_RCVBUF
-j group	: Join to Multicast group
-M ifname	: Multicast output interface
-c ch	: send to 1394 channel "ch"
-s ipaddr	: recv from src ipaddr
-S number	: recv packet with specific RTP payload number
-P port	: use UDP port "port"
-z sync	: sync

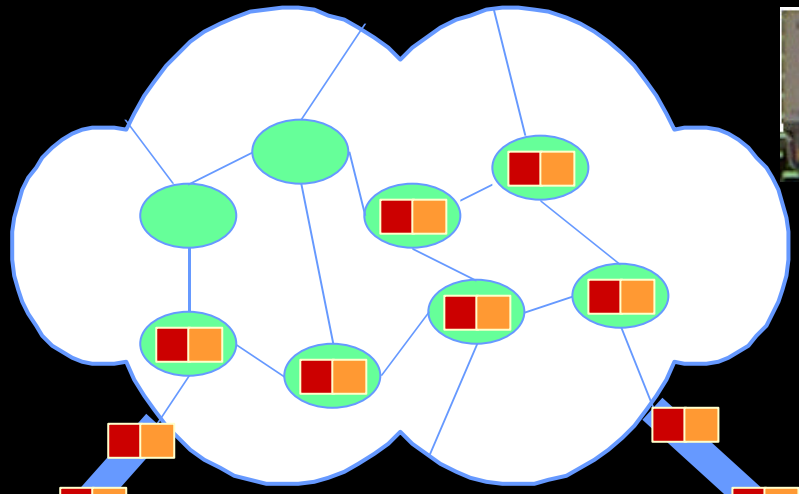
Next: DV software mechanism

DV Transceiver System

Consumer DV Camera

Consumer DV Deck

IEEE1394
Cable



Internet

IEEE1394
Cable

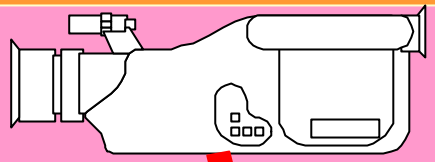
DV→Internet PC

Internet →DV PC

Next: DV IP Encapsulation

DV/IP Encapsulation

Sender



DV

1394 Header

DV

Application Header

DV

UDP

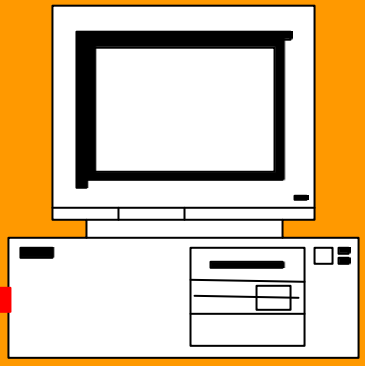
DV

IP

UDP

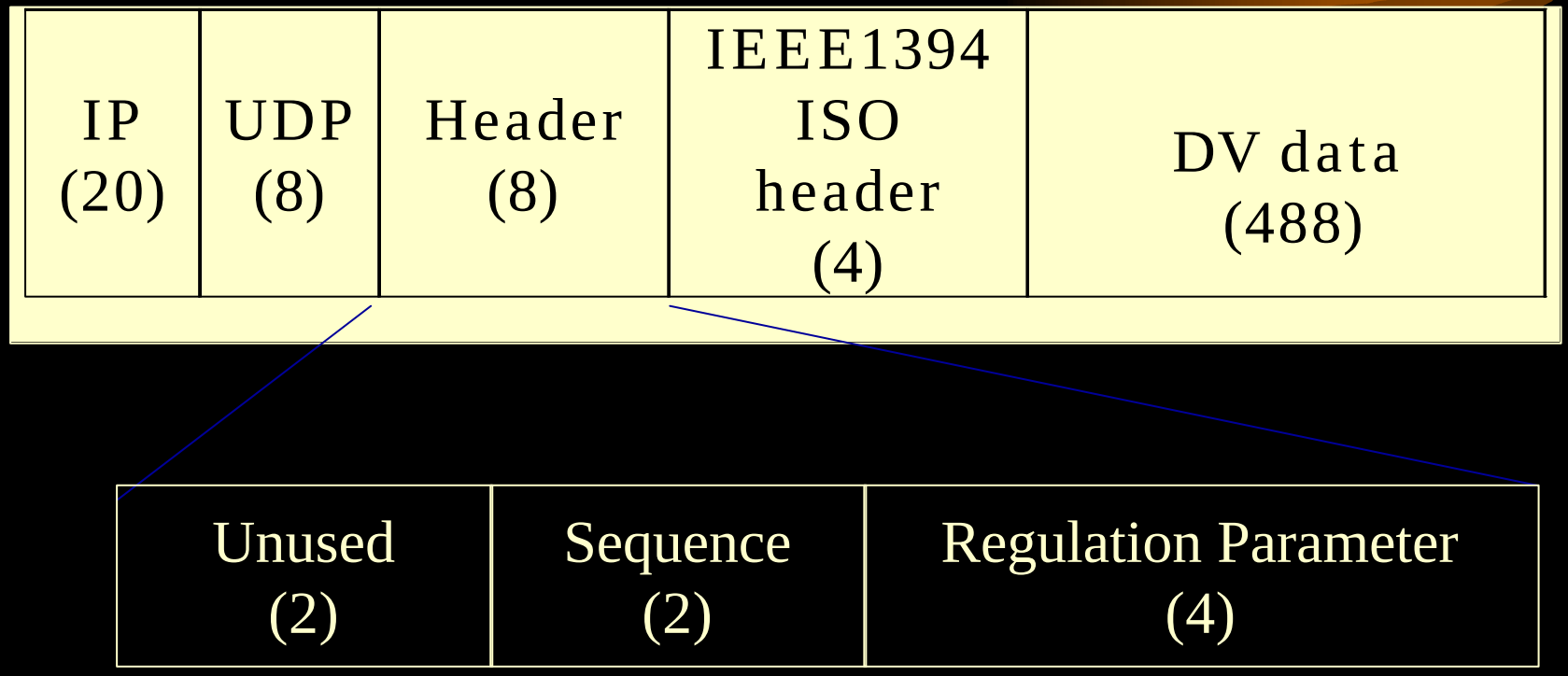
DV

Receiver



Next: Packet Format

Packet Format



Next: DV Packet Stream Control

DV Packet Stream Control

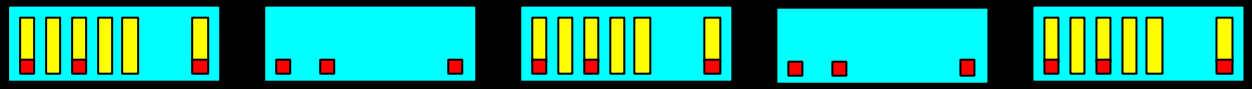
- Controlling the Packet flow of DV stream.
  - To conserve network bandwidth utilization...
    - cost for compression needs to be short
    - Complicated compression will require processing cost
- For Video Communications...
  - Full frame rate Video is not required
  - Full quality Audio is required
  - But...
    - continuous transmission is required
    - loss of audio packet is innegligible.

Next: Frame discarding

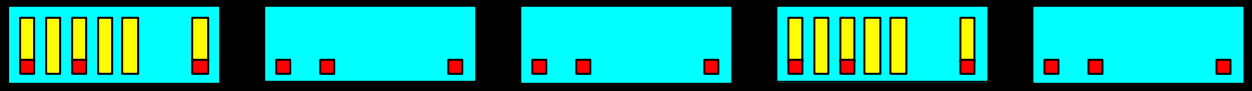
Frame Discarding

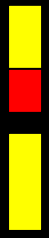
- **Full rate digital video stream**

- **Half rate digital video stream**



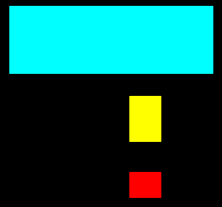
- **1/3 rate digital video stream**





DV Packet with Audio

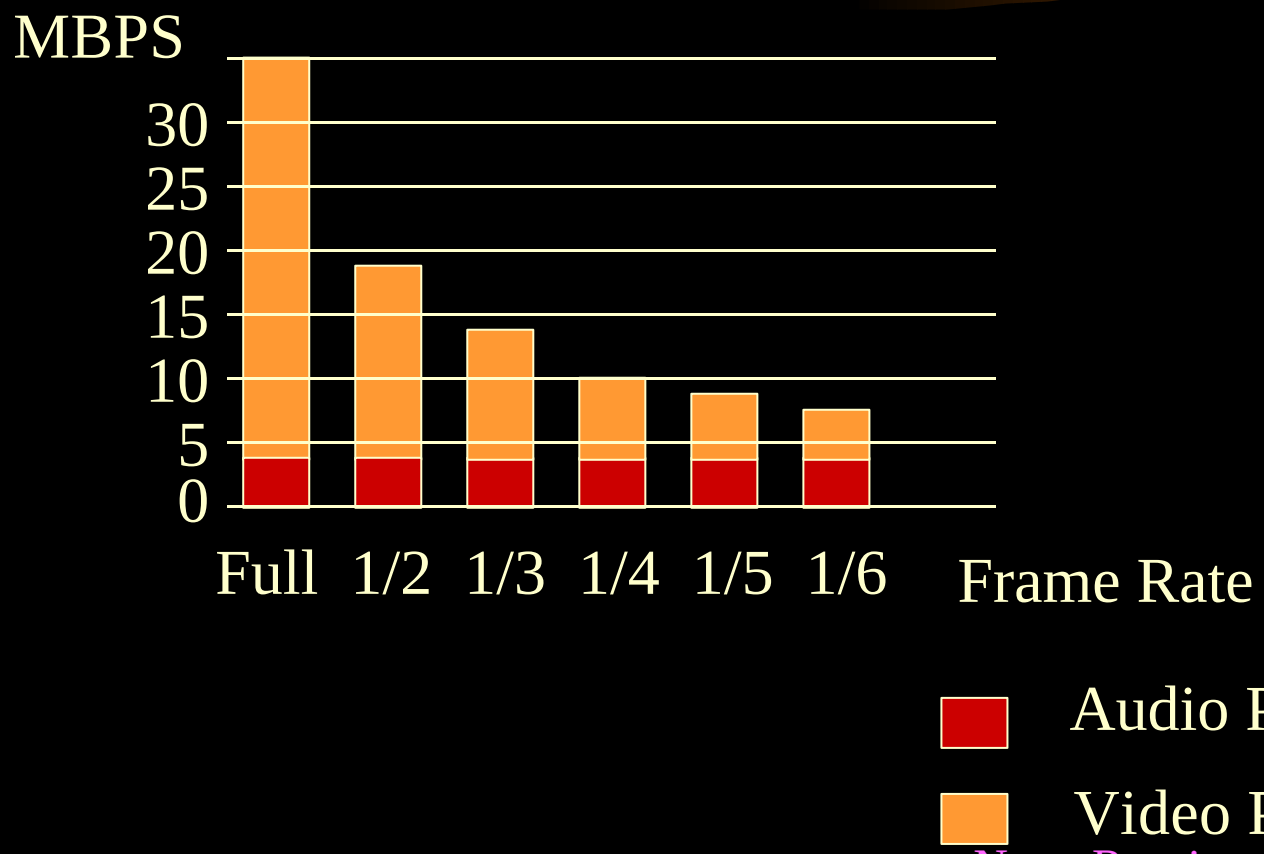
DV Packet without Audio



Video Frame(60 Frame/Sec)
Video data in frame
audio data in frame

Next: Frame rate and bandwidth

Frame rate and required Bandwidth

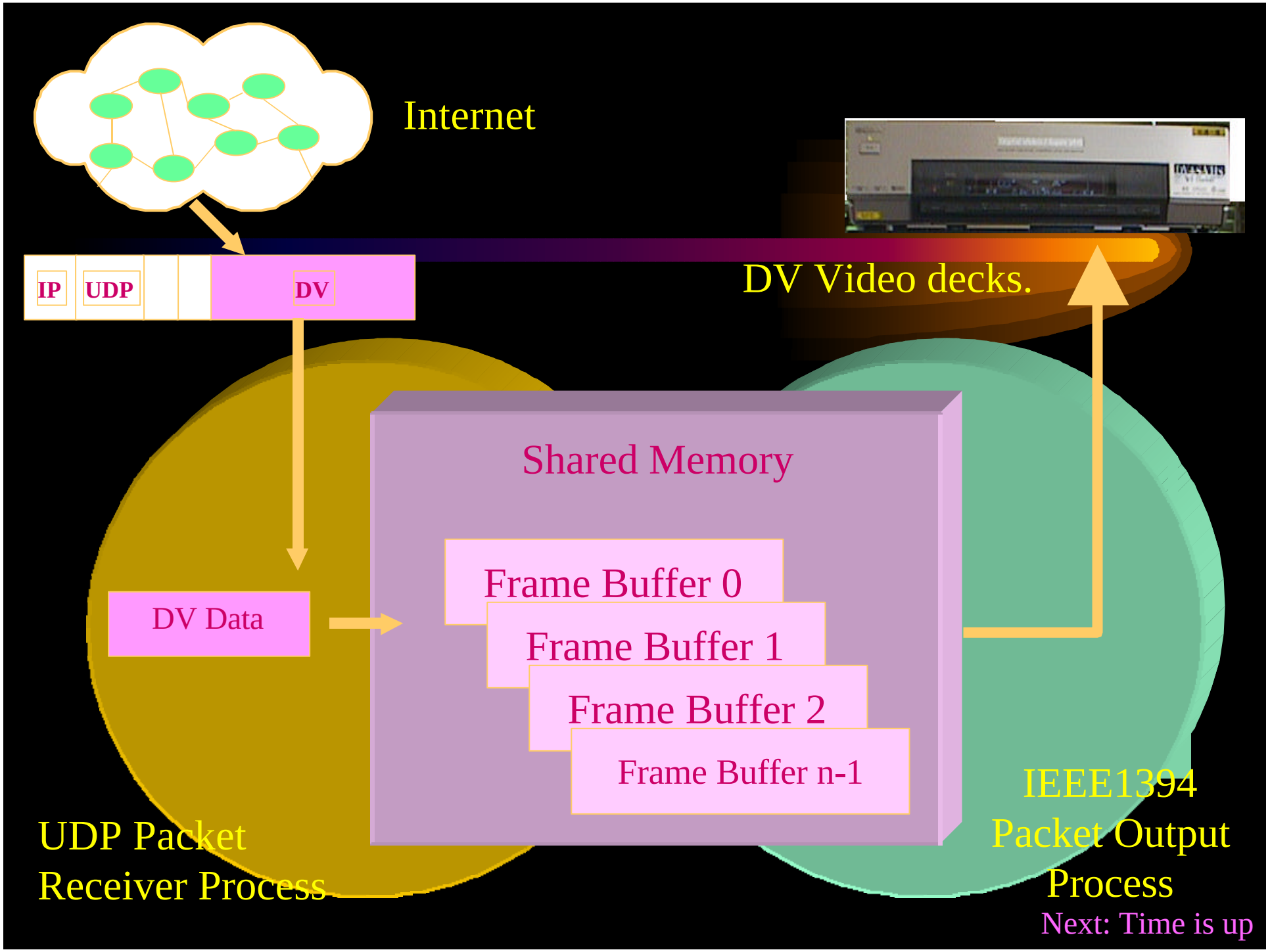


Next: Receiver implementation

Receiver Implementation

- ability to adapt to jitters and packet drops
  - simply uses previous data when packet drops
  - ability to use multiple buffers for video frames
- Receiver consists of two Unix processes
  - UDP packet receiving process
  - IEEE1394 packet sending process

Next: Schematic of dvrecv

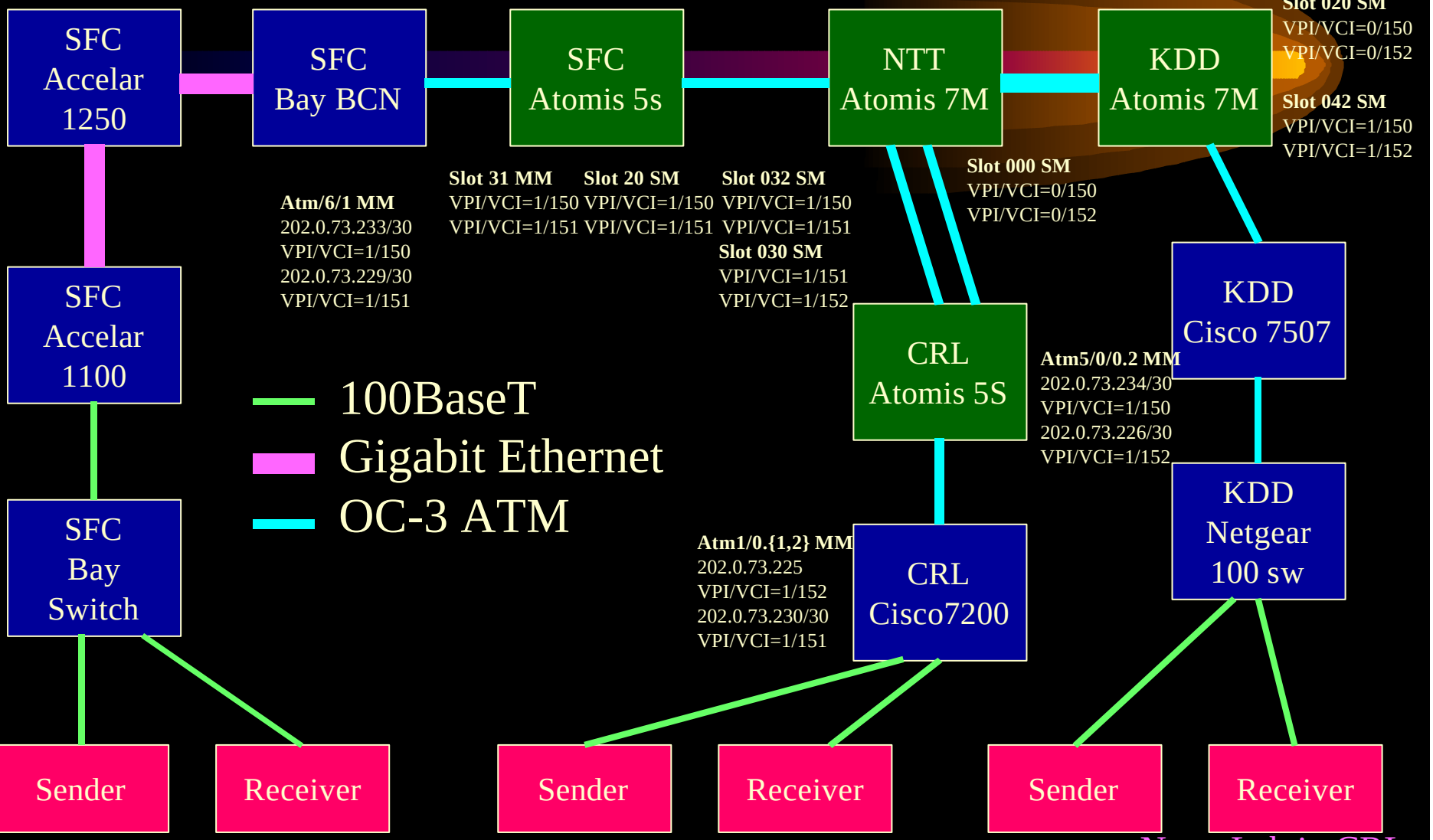

Internet
IP
UDP
DV
DV Video decks.
Shared Memory
DV Data
Frame Buffer 0
Frame Buffer 1
Frame Buffer 2
Frame Buffer n-1
UDP Packet
Receiver Process
IEEE1394
Packet Output
Process
Next: Time is up

I know most of people are worrying about the next session :-)

My time is UP? Sorry…. Still some slides to go...

Infrastructure we have tested….

Network Structure(1999/07/19)



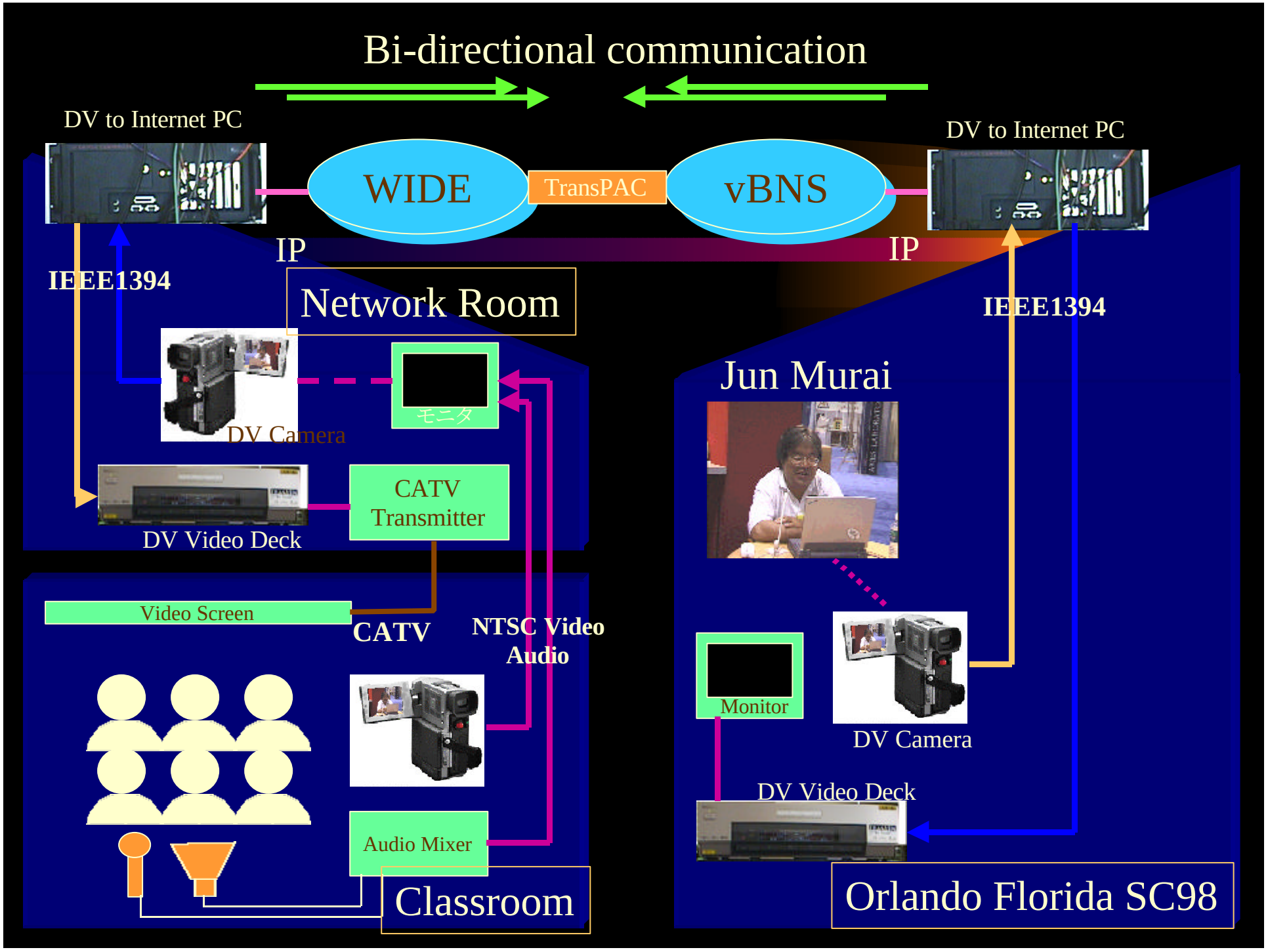
Next: Lab in CRL.

Lab in CRL.

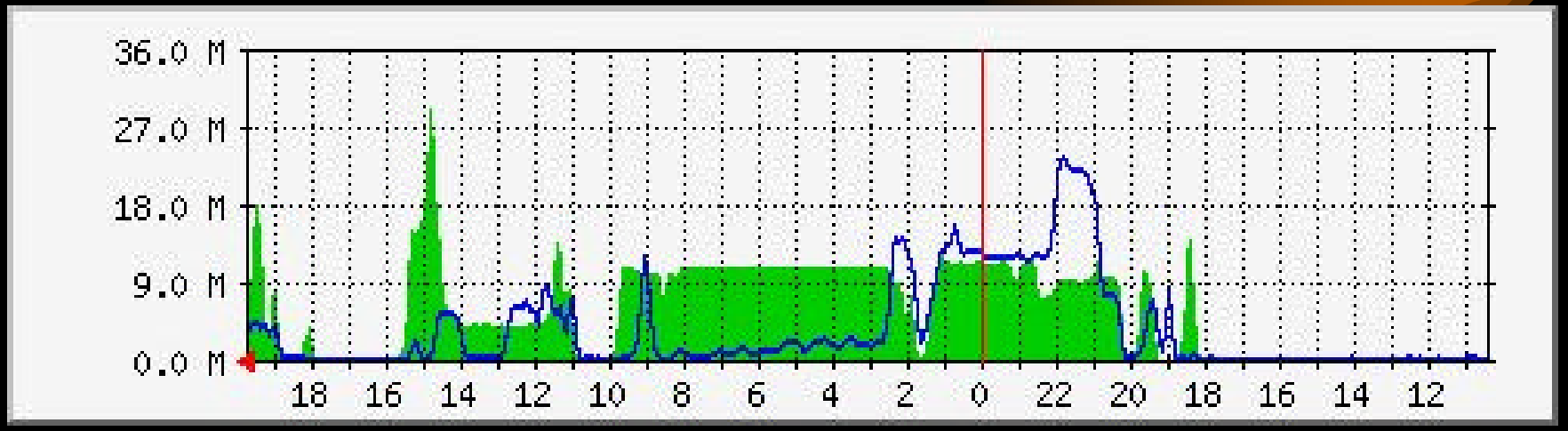
Next: Otemachi

Looking at a view of Otemachi at CRL.

DV Over IP Demonstration from Orlando Florida To Keio SFC

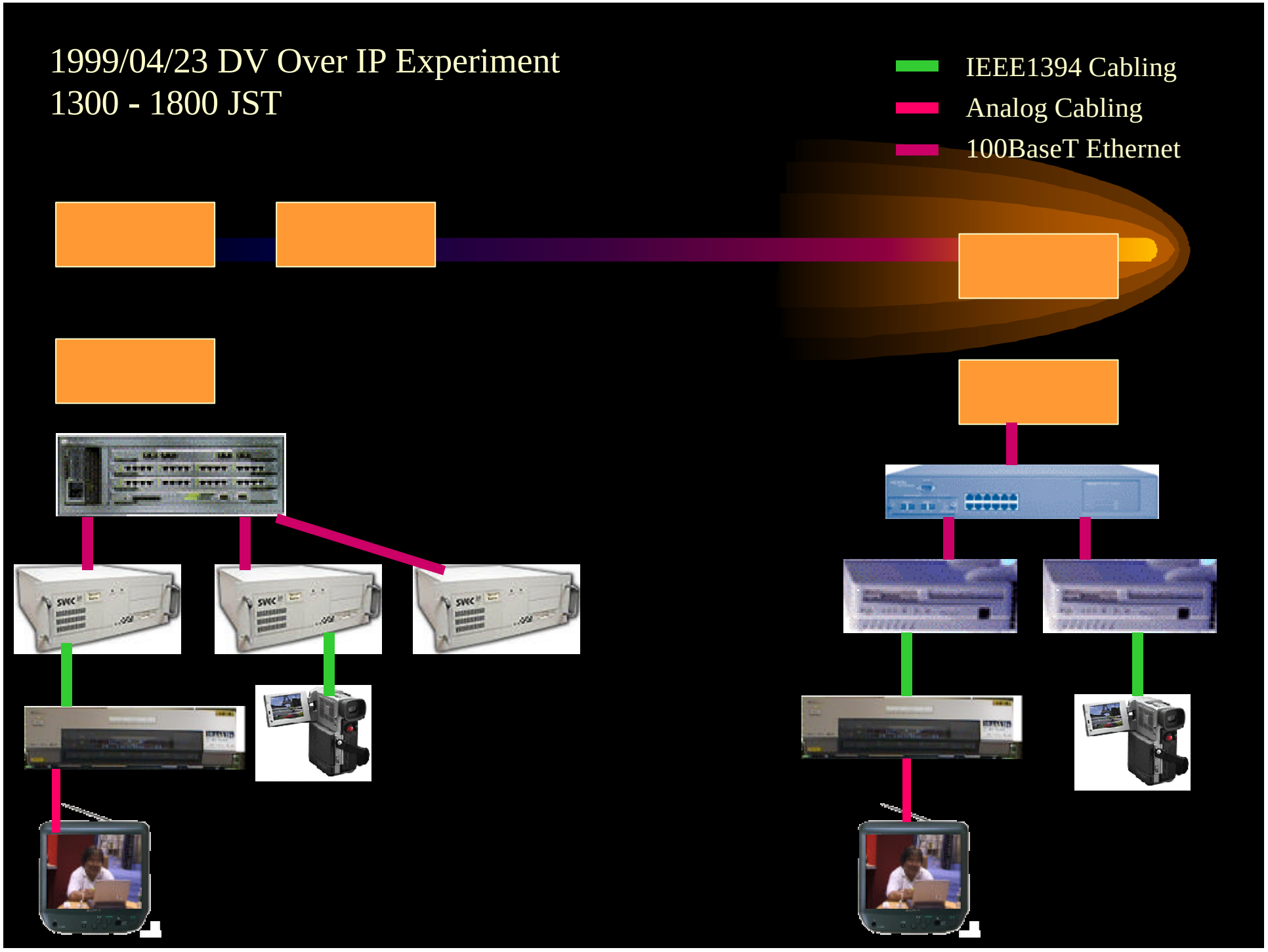

Bi-directional communication
DV to Internet PC
DV to Internet PC
WIDE
TransPAC
vBNS
IP
IP
IEEE1394
IEEE1394
Network Room
Jun Murai
モニタ
DV Camera
DV Video Deck
CATV Transmitter
Video Screen
CATV
NTSC Video
Audio
Monitor
DV Camera
DV Video Deck
Audio Mixer
Classroom
Orlando Florida SC98

Traffic Used at SC98

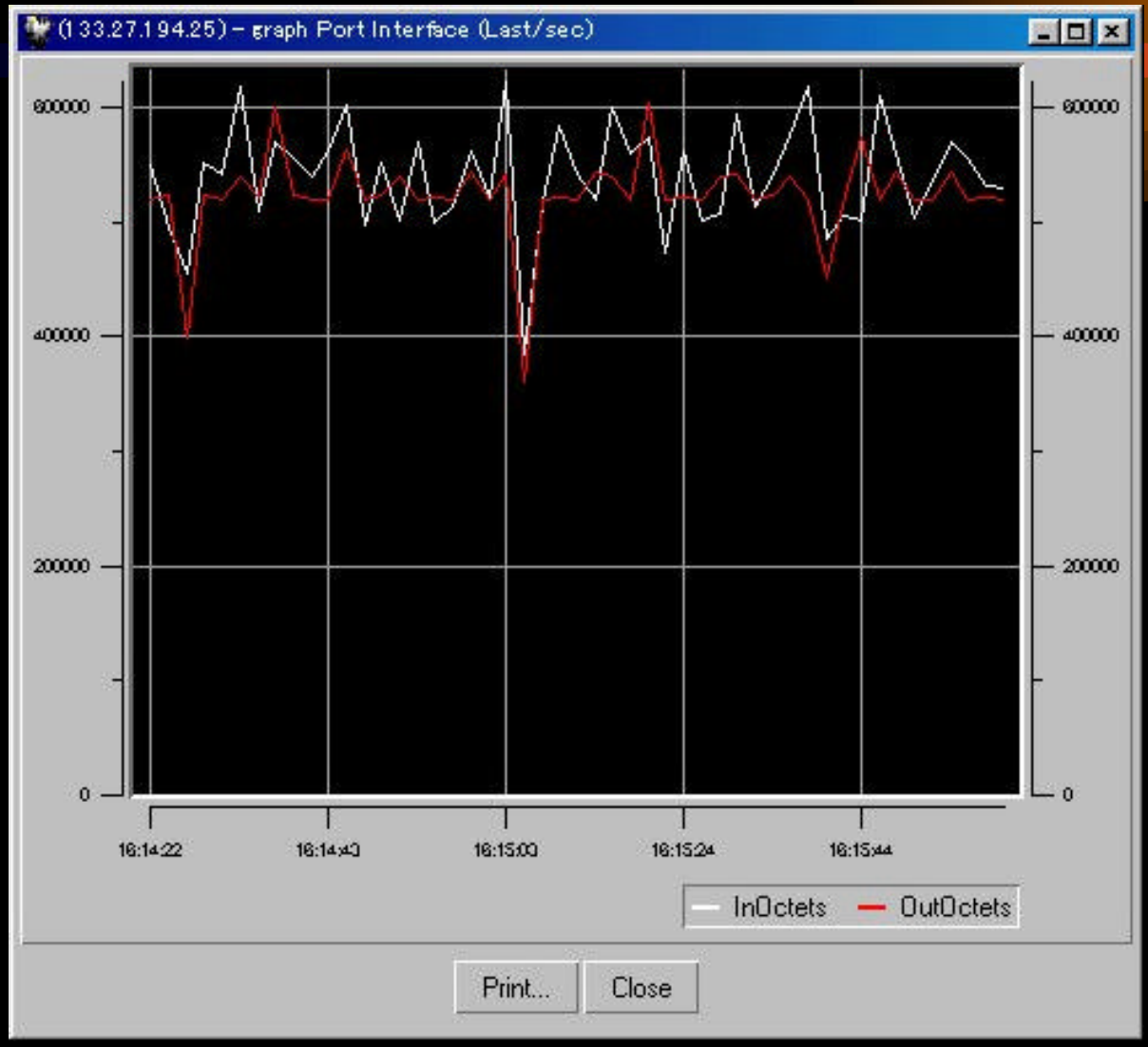


Green :Orlando → Japan

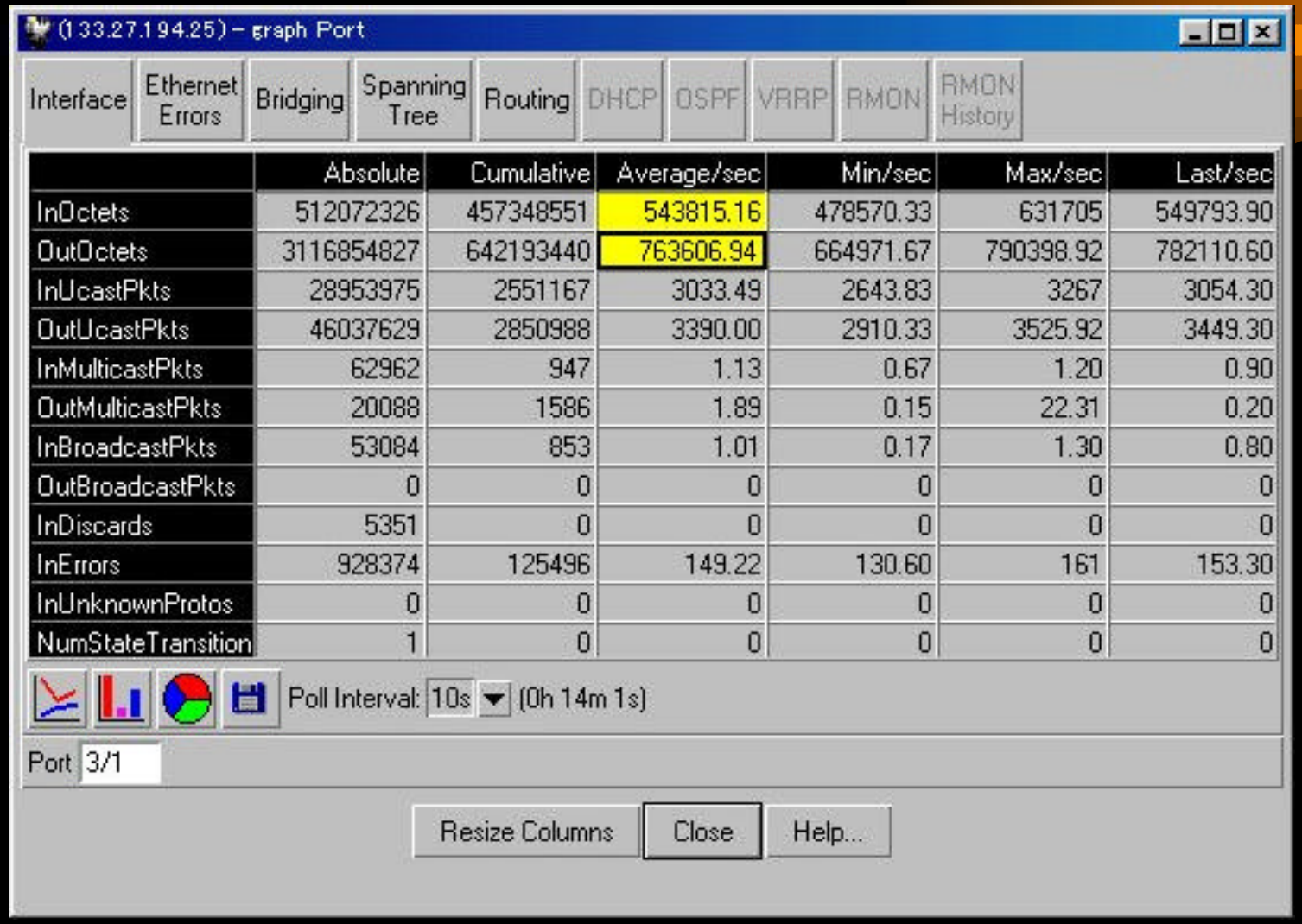
Blue Line :Japan → Orlando


1999/04/23 DV Over IP Experiment
1300 - 1800 JST
IEEE1394 Cabling
Analog Cabling
100BaseT Ethernet

Inbound, Outbound Traffic



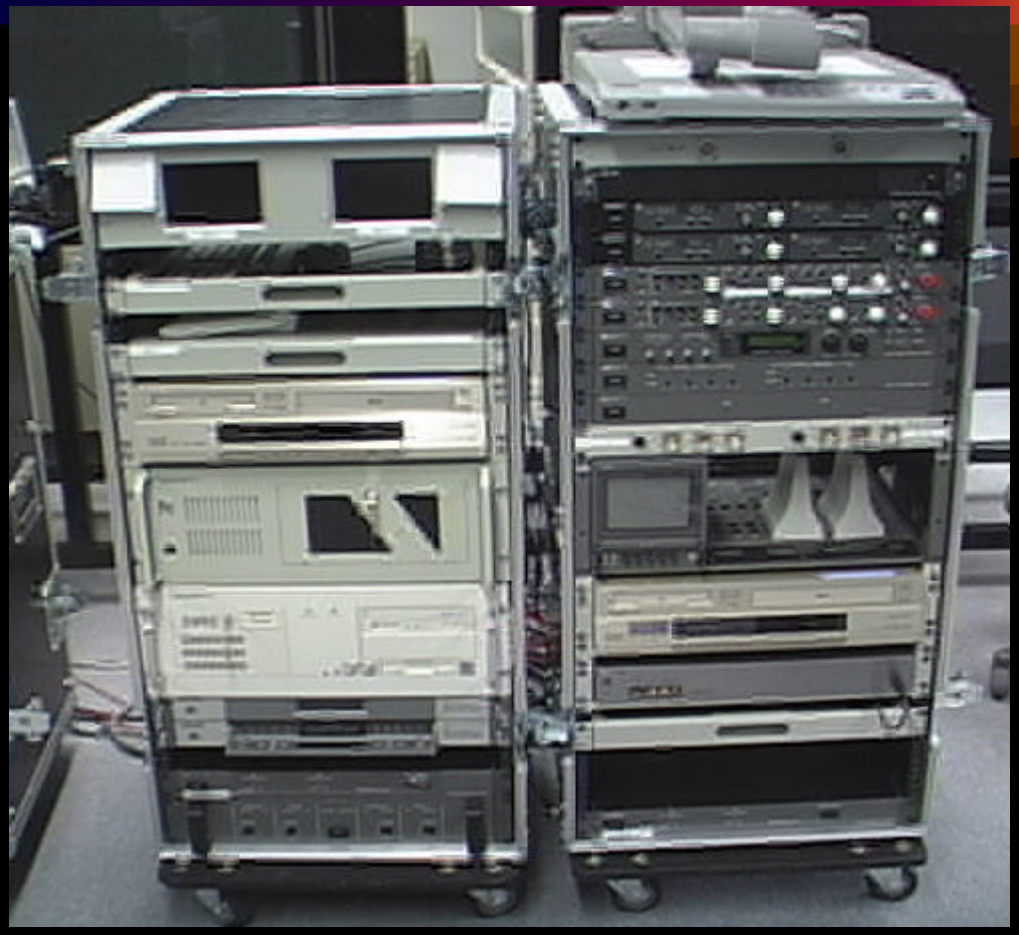
Uplink Ethernet Port



	Absolute	Cumulative	Average/sec	Min/sec	Max/sec	Last/sec
InOctets	512072326	457348551	543815.16	478570.33	631705	549793.90
OutOctets	3116854827	642193440	763606.94	664971.67	790398.92	782110.60
InUcastPkts	28953975	2551167	3033.49	2643.83	3267	3054.30
OutUcastPkts	46037629	2850988	3390.00	2910.33	3525.92	3449.30
InMulticastPkts	62962	947	1.13	0.67	1.20	0.90
OutMulticastPkts	20088	1586	1.89	0.15	22.31	0.20
InBroadcastPkts	53084	853	1.01	0.17	1.30	0.80
OutBroadcastPkts	0	0	0	0	0	0
InDiscards	5351	0	0	0	0	0
InErrors	928374	125496	149.22	130.60	161	153.30
InUnknownProtos	0	0	0	0	0	0
NumStateTransition	1	0	0	0	0	0

Internet Broadcasting Experiment

Internet Live
Broad and Multi-cast System



PC Monitor

Keyboard

DV Video recorder

Sender PC

Receiver PC

NTSC PAL SECAM
RGB Scan Converter

Main Power Supply

Wireless Mic.
Audio Selector

Video Input

Monitor, Antenna

DV Video Recorder

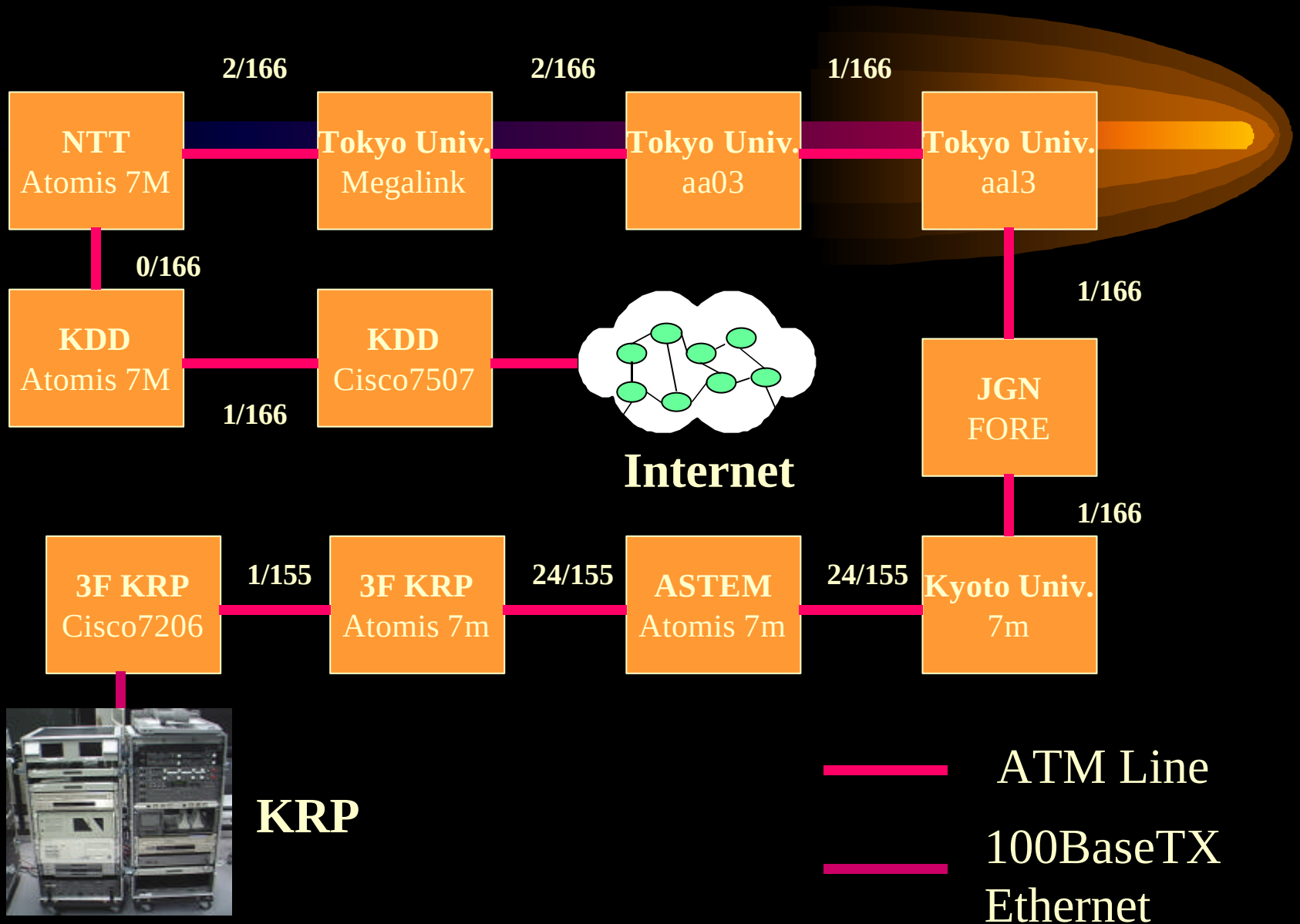
Video Selector

Main Power Supply

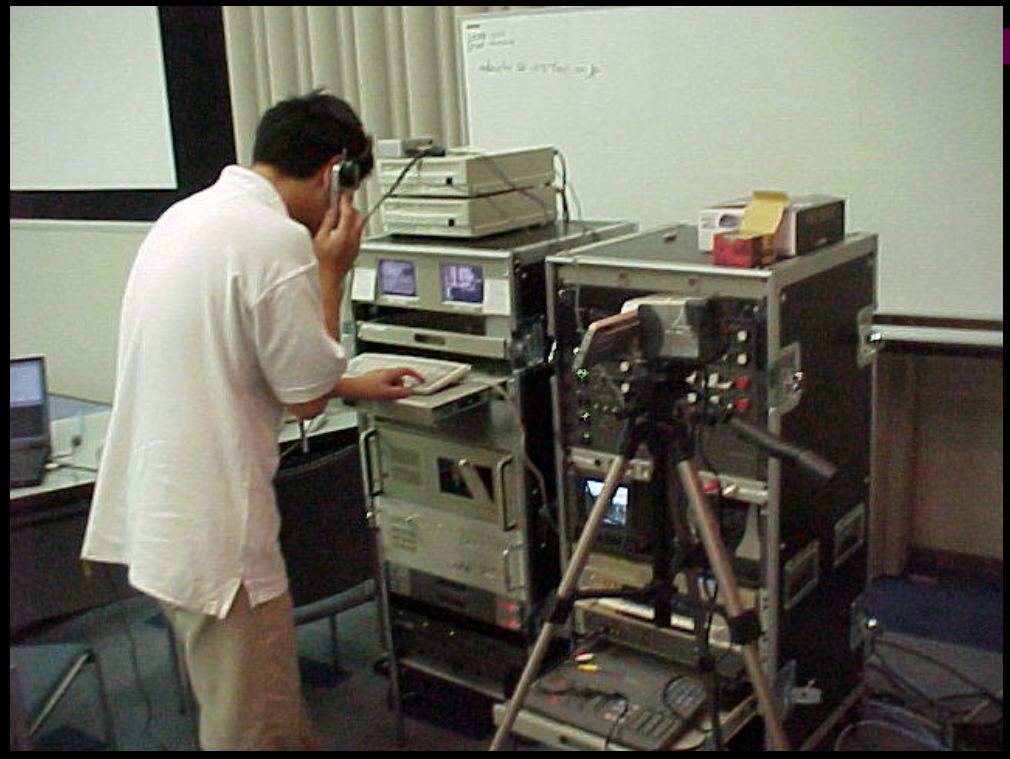
Rack 1

Rack 2

Internet Connection in ICWES(19990727)



Presentation in ICWES '99

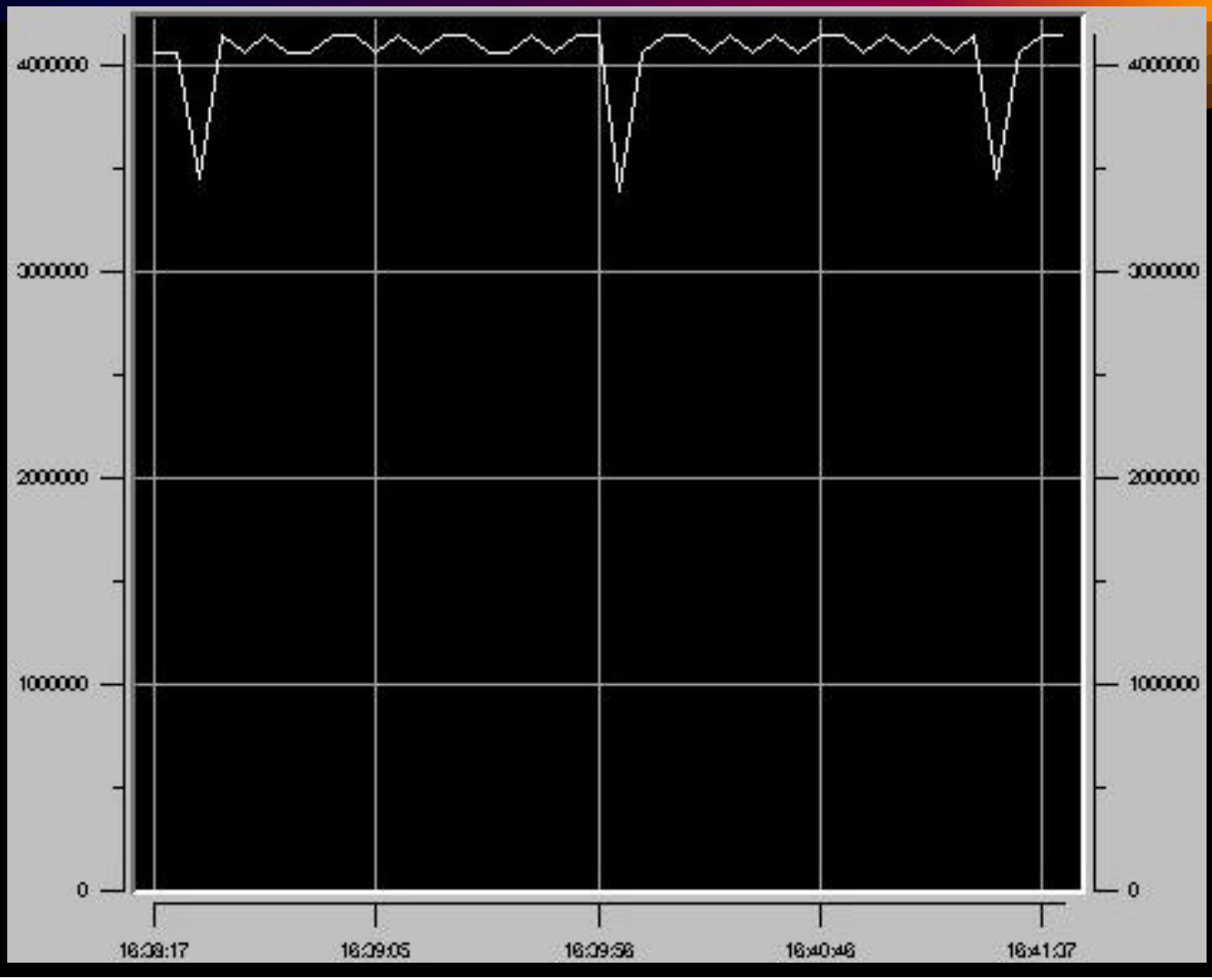


Inbound and outbound packets

input		(Total)	output			
packets	errs	bytes	packets	errs	bytes	colls
8059	0	3782898	8112	0	4091648	0
8081	0	3794338	8085	0	4069112	0
8083	0	3794858	8084	0	4069112	0
8082	0	3794358	8085	0	4069646	0

DV Conference System Network Traffic

Output Octets



Time

Todo…

- Hardware Support:
  - stability on Sony Vaio notebook iLink IEEE1394 Interface
    - Sony Notebook PC Plug and Pray(Play) architecture implementation.
  - Sender and Receiver in One Machine.
    - Device Driver Optimizaion
      - XXX Features…. Bus reset during session… XXX
- Operating System Support:
  - Implementation to RTMach
    - Realtime stream congestion control
- Application Support:
  - X Window based applications
- Media Conversion Support
  - Stream compression support for Thin networks.

Conclusion: For More Informations...

You can get the latest ppt files, sources, results, meeting logs, etc. at:

http://www.sfc.wide.ad.jp/~uhyo/STREAM/stream.html

I would like to apologize that some of the contents are written in 伝統的日本語(Traditional Japanese) :-)
English pages are also available.